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RESERVE

SUMMARY REPORT ON UTILIZATION RESEARCH

Fiscal Year 1961

**Agricultural Research Service
U. S. Department of Agriculture**

Prepared for

**Committee on Appropriations
United States Senate
87th Congress
2nd Session**

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SUMMARY REPORT ON UTILIZATION RESEARCH

Fiscal Year 1961

U. S. Department of Agriculture
Agricultural Research Service

This report is submitted in further response to the request made by the Committee on Appropriations in its report to the Senate on the Agricultural and Farm Credit Administration Appropriation Bill, 1960 (Report No. 330). This request, on page 4, paragraph 3, of the report under section entitled "Utilization Research" states:

"Further, the committee specifically requests that it be kept advised by an annual summary report on research developments, including the work in progress at these laboratories, proposed new work, and on projects to be discontinued due to completion of work or lack of results with the reasons for discontinuance. It is the hope of the committee that it will be kept better advised not only as to specific accomplishments in the field of utilization research but also as to fiscal requirements at these installations."

Previous reports concerning the utilization research activities of the Department, made in compliance with this request, were submitted in February 1960 and January 1961. These reports were for F. Y. 1959 and F. Y. 1960, respectively.

UTILIZATION RESEARCH AND DEVELOPMENT

Fiscal Year 1961

Agricultural Research Service
U. S. Department of Agriculture

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I. WHAT DOES UTILIZATION RESEARCH SEEK TO ACCOMPLISH?

The Department's Utilization Research and Development program seeks, through systematic chemical and other scientific research, to create new and improved uses for agricultural commodities. By this means, utilization research strives to maintain traditional outlets and to develop new products and processes utilizing the products of American farms, particularly those in surplus. There is increasing emphasis on developing large-volume industrial uses for agricultural materials. These new and improved products -- extending across the entire horizon of food, feed, and industrial uses -- are developed to meet specific needs of domestic markets and of foreign consumers. Successful utilization research enhances the use-value and competitive position of American farm products, thus benefiting the farmer, aiding industry, and providing consumers with better products.

II. WHAT HAS UTILIZATION RESEARCH ACCOMPLISHED?

In its two decades of operation, USDA Utilization Research and Development has added over \$2.5 billion of value to farm commodities at a cost of less than \$200 million -- representing a benefit-to-cost ratio of 15 to 1. Although there has been an increasing cost per man-year of research throughout this period, this continuing program of fundamental research and applied technology has resulted in spiraling advantages, with each succeeding year giving more return per year for the total expenditure. For example, during the past five years Utilization Research enhanced agricultural commodities \$1.75 billion, which is 70% of the total gain made in the two decades of this program. This increasing rate of return is expected to continue, as the storehouse of scientific and technologic information is accumulated.

III. HOW DOES UTILIZATION RESEARCH OPERATE?

USDA's utilization research is conducted in four regional laboratories (Albany, California; New Orleans, Louisiana; Peoria, Illinois; and Wyndmoor, Pennsylvania) and ten related field laboratories (Prosser and Puyallup, Washington; Pasadena, California; Weslaco, Texas; Houma, Louisiana; Winter Haven and Olustee, Florida; Raleigh, North Carolina; Beltsville, Maryland; and Washington, D. C.). These utilization laboratories are operated in close association with other Department research. Much of the research is undertaken cooperatively with State Experiment Stations, colleges and universities, manufacturers, and other agricultural groups. Cooperative work is achieved in various ways; some is under contract.

Utilization research includes both basic and applied investigations in chemical, biological, physical, engineering, and other sciences necessary to accomplish the objectives. Much of the fundamental laboratory research is extended to pilot plant studies, and those showing promise are cooperatively evaluated under commercial manufacturing and use conditions. A Product and Process Evaluation Staff assists in formulation of research projects to better assure that the work is constantly directed to find timely, economic solutions to urgent problems of American agriculture. During this past year, 16 technical reports, concerning the present consumption and potential new uses of agricultural materials, were reported by the PPE Staff to assist in formulating utilization research projects.

About three years ago a foreign program of utilization research was initiated, supported by funds generated under P. L. 480, to supplement the domestic efforts to find new uses for farm products. This foreign program, stressing basic research, is now established in 10 countries of Europe, Asia, and South America. New concepts and basic information emanating from these foreign laboratories already are proving helpful in finding new uses for American agricultural crops. Twenty-eight new utilization research projects were started in foreign laboratories during F. Y. 1961, bringing the total to 75 such grants. Additional foreign research projects are under consideration, and many of these are expected to be put into effect during F. Y. 1962.

IV. HOW IS UTILIZATION RESEARCH INFORMATION MADE AVAILABLE?

Scientific knowledge and technolgc advances developed by the USDA Utilization Research and Development program are made available for public use as rapidly as practical. In the past 20 years these scientific efforts have resulted in over 9,000 research publications and more than 1,000 patents. Among the many ways of disseminating this technical knowledge, it is interesting to note the following statistics for F. Y. 1961:

75 patents obtained

600 research papers published

608 speeches, press releases, and appearances
on radio and television

38 formal conferences with industry

27 public-service exhibits

5,500 technical visitors to UR&D laboratories

Three examples are illustrative of the breadth and scope of USDA efforts to make the new scientific information available and useful for the public benefit.

A. Formal Meetings With Experiment Stations

In addition to frequent conferences and correspondence covering specific work, the Utilization Research and Development Divisions usually participate in two types of formal annual meetings with representatives of the State Agricultural Experiment Stations. One of these is the two-or three-day meeting with the State Experiment Station collaborators (one or two technical personnel from each Station) at which scientific techniques and findings are thoroughly reviewed in selected research areas.

Others are the annual regional meetings held by the Directors of the State Experiment Stations. At the 1961 Eastern regional meeting, the UR program discussion included potatoes and other vegetables, deciduous fruits, honey, maple products, and tobacco. The research being done at the Southern Utilization Research and Development Division in F. Y. 1961 to improve cotton quality -- concerning fundamental studies on fiber, mechanical processing, effect of short fibers, and wash-wear fabrics -- was presented at the directors' meeting of the Southern Experiment Stations. During this

past year the directors of the Western Experiment Stations heard Western Utilization Research and Development Division representatives discuss research on easy-care wool treatments, new industrial oilseed crops, dehydrated egg products, and new wheat foods (based on WU-developed bulgur) which have good potential for increasing food use of wheat both domestically and abroad.

B. UR Exhibit at Midwest Business Opportunities Meeting

Under the auspices of six Midwest states, a four-day meeting was held in St. Paul, Minn. (October 1961), to inform leading manufacturers of the opportunities for commercializing newly developed products, processes and equipment. In addition to commercial firms, ten Federal agencies including USDA Utilization and Development, participated. These discussions centered around well-planned, sizeable exhibits depicting the latest developments.

C. Liaison Activities Related to National Emergencies

F. Y. 1961 saw an accelerated effort to exchange research knowledge with Federal groups concerned with preparedness for national emergencies. The growing interest in construction and supplying of fall-out shelters has given impetus to seeking more information on USDA-developed ready-prepared foods. Of particular concern is the bulgur wheat wafer, developed at the Western Utilization Research and Development Division, for feeding shelter inhabitants.

USDA, U. S. Atomic Energy Commission, and U. S. Public Health Service have undertaken a joint research effort to develop a feasible commercial-scale process, to be used in case of national emergencies, for the removal of radioactive contamination from milk. A continuous pilot plant process, using commercially obtainable equipment, has been developed which removes over 90% of strontium 90 with little or no effect upon the flavor and stability of the milk. The research is continuing in an effort to refine the resin regeneration phase, to explore other removal procedures that might be more efficient, and to study the problems of adapting a pilot plant process to commercial use.

Liaison with the Quartermaster Corps has been intensified so that the military will be able to take immediate advantage of USDA research and development. A cotton technologist from the Southern Division has been assigned to work at the research laboratory of the QM Research & Development Command at Natick, Mass. in order to improve the exchange of technical information on new ways to chemically and mechanically modify cotton fibers to give special performance characteristics to cotton fabrics. Real interest has been evinced by the military in the new Utilization Research processes for giving wool and cotton wash-wear properties. The exchange of technical information on new UR processes for tanning leather has continued in an effort to broaden the use of animal hides and to better serve any military need.

V. PROGRAMMING TO MEET CHANGING NEEDS

A. Planning

Utilization research planning, as an integral part of the Agricultural Research Service program, is a continuously changing pattern of finding efficient ways to convert imaginative ideas to tangible, economic products and processes through coordinated scientific studies. This research planning has the benefit of the advice and cooperation of many organizations and individuals both within and outside the Department of Agriculture.

One of the foremost sources of assistance in research planning is the newly created Product and Process Evaluation Staff, a segment of the staff of the Administrator of ARS which focuses the talents of economists, chemists, and engineers on the commercial and industrial promise of utilization research and development projects proposed to the Administrator from all sources. Its function is to bring together those pertinent economic and technical facts which bear on the usefulness of the proposed research and to make recommendations based on them which will assure the commercial usefulness of the development program.

Another major source of assistance in research planning is provided by the Research and Marketing Act of 1946, whereby the Secretary of Agriculture appoints an over-all policy committee (currently known as the National Agricultural Research Advisory Committee consisting of eleven members) and a number of commodity and functional advisory committees (at present 24).

Of inestimable value in research planning are the extensive contacts maintained with growers, processors, transportation and storage organizations, distributors, and consumers to obtain detailed information on the needs for new products and processes, on the success or shortcomings of previous developments, and on the long-range outlook affecting all farm commodities.

About forty carefully selected specialists are retained on a "when employed" basis to give advice and to supply information in various fields of research. These consultants render invaluable assistance in research planning.

Aided by the information and ideas emanating from these many sources, the utilization research program is constantly under critical review, and modifications made in the program to keep pace with the changing needs. Unproductive research efforts are curtailed or discontinued, and new lines of investigation initiated, to the extent resources permit, to find additional ways of converting agricultural materials into products for large-volume, profitable uses.

B. Program Modifications

All phases of utilization research are under constant review to assure that the efforts are directed to timely solving of significant problems. The following examples illustrate redirection of research activities to maximize fruitful achievements.

Completion of studies on quality factors of foreign rices, the discontinuance of cooperative studies on the processability of rice varieties grown under varying cultural conditions, and completion of a phase of developing improved methods for evaluating wheat flours, made resources available for the initiation of exploratory studies on preparation of new food products from the wheat protein mixture, gluten, with the aim of extending export markets for U. S. wheat.

Successful completion of studies which led to the isolation and identification of a powerful estrogenic growth-promoter in forages, made possible expanded research on biologically active components in processed forages and applied studies on enhancing favorable factors and ameliorating the effects of unfavorable components.

Contract research on improved bleaching of wool, in order to make domestic off-color wools more competitive with imports, were initiated by resources available upon the successful completion of studies which yielded improved finishing treatments for fabrics that had been resin-treated to impart shrink-resistance.

Successful development of commercially practical process for shrinkproofing of wool with epoxy resins released resources to expand studies on the interfacial polymerization treatment -- a process that yields shrinkproofed, muss-resistant fabrics that can be further processed to produce durable pleats and creases.

The successful completion of an important phase of frozen fruit research, in which added stability of products packed in bulk containers was clearly demonstrated, allowed initiation of studies on improved processing methods for dried fruits.

Identification of the polyunsaturated fatty acids present in egg yolk was successfully completed, and released resources for increasing basic studies on the characterization of oxidative mechanisms in the egg lipid system -- information important in interpreting and correcting undesirable flavor deterioration induced by processing.

Completion of the major phases of work on potato flakes, and wide industrial adoption of the process, have enabled shifting of engineering personnel to expedite the pilot plant development of the new process for "instantizing" dehydrated vegetables and fruits.

Work on the preparation from animal fats of resinous copolymer materials has been curtailed since the preparation of copolymers of vinyl stearate carried out in this field has attained commercial production. Research on monomers and polymers from animal fats is being redirected toward the synthesis of new monomers and other more basic lines of investigation.

On completion of studies of indigenous meat components as factors determining binding in meat and meat products, a new investigation was initiated which is concerned with study of the chemical activity on meat of curing ingredients, the substances which control binding in processed meats.

Completion of exploratory studies on the substances responsible for meat flavor and aroma indicated that these substances are derived from precursors consisting of carbohydrates, polypeptides, and amino acids and led to a reorientation of the direction of the research effort to concentrate on the problem of isolating and characterizing these specific precursor compounds.

Research on the isolation of maple sap fractions which are responsible for color and flavor of maple sirup was completed as a prelude to chemical characterization of the color and flavor constituents.

Research on the hexane-soluble constituents of flue-cured tobacco was completed and personnel were reassigned to work on the correlation of lipid constituents with tobacco quality.

Development of a successful method for detecting antibiotics in milk was successfully accomplished, and the personnel have been reassigned to new research on methods for making low-fat cheese.

Research on development of a machine for rapidly determining the foreign matter content of lint cotton was successfully completed and the resources transferred to new research to develop a machine for removing short fibers from cotton.

With the development of an experimental apparatus for spinning cotton yarns without rings or travelers, the research was terminated and the effort transferred to augment research on the design of optimal structures for cotton fabrics for wash-wear products.

Engineering studies on the development of a process for making dialdehyde starch were successfully completed and personnel reassigned to expanding investigations on dry-milling hard wheat and to developmental studies on the chemical modification of wheat flour and flour fractions.

Cooperative studies with oat breeders to increase the vitamin content of oats were successfully completed and personnel reassigned to developing new chemicals from cereals.

A fermentative process for preparing carotene (vitamin A precursor for food and feed) from grains was successfully achieved, and personnel reassigned to explore fermentative processes for the production of xanthophylls (a feed supplement).

Studies on characterization of sterols in wheat were successfully completed, showing the presence of physiologically active sterols that are important to the feeding value of the milled feed fractions of wheat, and resources diverted to exploratory studies on the reaction of acetylene with starch to produce new starch products.

Engineering studies on the development of a process for preparing linseed and soybean oil vinyl ether resins were successfully completed and personnel reassigned to the development of a process for recovering erucic acid oil and feed meal from mustard seed, a potential new crop for the Montana region.

Laboratory studies on the preparation of plasticizers from soybean and safflower oils were successfully completed and personnel reassigned to expand work on the development of linseed oil water-emulsion paints.

Exploratory studies on the fermentative conversion of vegetable oil fatty acids to new hydroxy fatty acids showed this approach to be economically unfeasible, and efforts were redirected toward the fermentative production of amino acid derivatives.

Work was successfully completed to develop pulping processes for timber bamboo to produce paper and paper products, and personnel were reassigned to study the pulping properties of kenaf and other potential annual fibrous crops, and to expand investigations on new oilseed crops.

C. New Research Initiated With Increased Funds

Additional research was made possible by an increase in appropriated funds in F. Y. 1961:

- (a) Expanded basic studies on wheat proteins and polysaccharides to increase food and feed uses of wheat.
- (b) Exploratory studies to convert wheat flour into water-resistant, plasticlike chemical derivatives having properties suitable for industrial use in structural and insulating products and in molding compositions.
- (c) Development of mass production methods for growing bacterial spores for controlling Japanese beetle infestations.
- (d) Broadened development of optimal structures for cotton fabrics to produce wash-wear products having maximum recovery from wrinkling, maximum resistance to abrasion and tearing, good tenacity and drapability when resin treated, and improved soil resistance.
- (e) Development of new types of yarns and fabrics from the coarser grades of wool, which represent the bulk of domestic wool production, and application of new physical and chemical treatments to obtain products suitable for a wide variety of garment uses.
- (f) Expanded research on the chemical and biological properties of castorseed proteins for use in developing effective deallergenation methods for castor-meal, thus broadening the use of this oilseed crop.
- (g) Develop new outlets for surplus inedible animal fats through (1) chemical research investigations on the synthesis of new fatty compounds and (2) evaluation of these products for industrial uses, such as special type lubricants and plastic chemicals.

D. Utilization Research Projects Terminated

A total of 124 research projects were terminated in F.Y. 1961 for the following reasons:

Research objectives attained	62
Research objectives partially attained	29
Research results unpromising	3
Superseded by research of high priority	
or of more productivity	9
Exploratory research completed to define	
specific phases of a problem	21

Total Terminated124

E. Utilization Research Projects Initiated

One hundred twenty-five new utilization research projects were initiated in F. Y. 1961. Of this 125, new domestic projects totalled 97, with 28 new projects being placed in foreign laboratories.

COMMODITY	INDUSTRIAL USES	FOOD USES	FEED USES	TOTAL
Cereal grains and forages	19	8	4	31
Cotton and wool	20	--	--	20
Fruits and vegetables	--	12	--	12
Oilseeds	10	7	9	26
New and special crops	6	5	1	12
Poultry, dairy and animal products	7	17	--	24
	62	49	14	125

VI. COOPERATIVE RESEARCH WITH OTHER ORGANIZATIONS

A dynamic utilization research and development program must consistently seek new ideas, get suggestions for new needs, and have real-use appraisals of the products and processes under development. One of the best ways of achieving such objectives is through cooperative undertakings with outside organizations. Below are outlined some examples of current collaborative work with industry, State Experiment Stations, academic institutions, and other Federal agencies.

Research in cooperation with Archer-Daniels-Midland Co., an industrial protective coatings manufacturer, is providing important information on evaluation of linseed and soybean vinyl ether coatings for use as can coatings.

High-amylose corn, needed as a source of high-amylose starch for a wide range of industrial uses being developed by utilization research, is being developed through cooperative research with the Missouri Agricultural Experiment Station and the Bear Hybrid Corn Company.

The Utilization Research cooperative program with the National Flaxseed Processors Association on the development of emulsion-type paints using polymerized linseed oil products, is resulting in new commercial outlets for linseed oil products.

In cooperation with the Florida Citrus Commission, Department research is directed toward commercial adaptation of its newly developed "foam-mat" drying process for production of high quality citrus powders that readily reconstitute with cold water.

Research conducted by the Department, in cooperation with the Canvas Products Association International and the Foundation for Cotton Research and Education (affiliated with the National Cotton Council of America), has demonstrated that suitable blends of pigments impart outstanding protection to cotton against biologic deterioration and degradation due to sunlight.

Research sponsored by the Office of the Surgeon General, and conducted in cooperation with the Louisiana State University Medical School and several research groups, has developed new and improved fat emulsions for intravenous feeding.

Better soybean meals for animal and poultry feeding are being developed in a 3-way cooperative venture by USDA Utilization Research, Mississippi Agricultural Experiment Station (Crops and Animal Husbandry), and an industrial processor.

Cooperative work with the National Cottonseed Products Association (which supports a Fellowship in USDA) has led to the isolation and determination of some of the properties of the physiologically active Halphen-positive fatty acid in cottonseed oil and meal, a material found to accentuate egg yolk discoloration problems in stored shell eggs.

Excellent progress has been made in developing special intumescing fire-retardant protective coatings from tung oil and other domestic oils in cooperation with the U. S. Army Engineer Research and Development Laboratories.

In cooperation with the Pesticide Chemicals Research Branch, Entomology Research Division, a unique type of phosphorus compound called "APN", prepared by utilization research scientists in the course of work on chemical modification of cotton, has been found in initial tests to be a promising chemosterilant.

USDA's utilization research to develop new uses for leather is being materially assisted by industry cooperation, and gives promise of early adoption of a new tanning process that should broaden use of leather as outer garments.

The USDA, U. S. Atomic Energy Commission, and U. S. Public Health Service have a joint program for developing processes for removal of radioactive contaminants from processed foods, with initial efforts devoted to removal of Strontium 90 contamination from milk.

The Agricultural Research Service, the Agricultural Marketing Service, and a manufacturer have cooperatively conducted a retail market test on full-flavor superconcentrated (7-fold) apple juice, developed in Utilization Research laboratories, which indicates high acceptance.

Fruit juice concentrates and concentrated fruit aromas (essences) recovered, by processes developed in Utilization Research, have been cooperatively evaluated with the University of Maryland for use in frozen dairy products.

Through cooperation with State Experiment Stations, State and Federal Extension personnel, State foresters, county agents, and industrial representatives in New York, Vermont, New Hampshire, Pennsylvania, Ohio, Michigan, Wisconsin, and Minnesota, new USDA processes for making better maple products are being rapidly adopted by the maple industry.

In cooperation with the Kansas Wheat Commission and the Trenton Foods Company, the first commercial manufacture of canned whole-kernel bulgur products, a new use for wheat developed by Utilization Research, was successfully accomplished. The market success of a market test, made cooperatively with the Agricultural Marketing Service, has resulted in the present commercial distribution of this new product.

Industry cooperation, through supplying sera from employees sensitized to handling castorseed, has assisted greatly in the Department's development of a diagnostic test for allergenicity -- a vital link in broadening the uses for castorseed products.

A collaborative research program, consisting largely of studies of composition and stability of dried fruit products, is being conducted at one of the Department's Utilization laboratories with financial support from the California Raisin Advisory Board, California Prune Advisory Board, California Dried Fig Advisory Board, and the Dried Fruit Association.

Cooperative studies on improved processing, feeding experiments, and crop genetics concerning the estrogenic growth promoter, coumestrol, present in fresh and processed forage legumes, have been conducted by Utilization Research of USDA, Nebraska and Oregon State Experiment Stations, and the American Dehydrators Association.

In cooperation with the California Rice Experiment Station -- and jointly supported by private, state, and federal funds -- a comprehensive study has been undertaken to determine the relationships between stage of maturity at harvest and processing characteristics of western grown rices.

VII. CURRENT UTILIZATION RESEARCH PROGRAM (F.Y. 1962)

Utilization Research and Development employed 958 scientific and technical personnel in its four regional and ten associated field laboratories as of July 1, 1961.

The current program -- at the beginning of F. Y. 1962 -- consisted of:

228 projects in the USDA utilization laboratories supported by regular appropriations (exclusive of projects under domestic contracts).

64 projects under domestic contracts.

12 projects in USDA utilization laboratories supported by funds transferred from other Federal agencies.

27 projects directly supported by industry (fellowships).

75 projects in 10 foreign countries under Public Law 480.

Each field of utilization research encompasses a broadening base of fundamental studies, engineering investigations including pilot plant work for converting laboratory findings to practical commercial applications, and pharmacological evaluations to assure safe usage.

Cereal Grains and Forages

Principal interest is focused on wheat and corn, with substantial research on rice, barley, sorghum, oats, and alfalfa and other forages.

New processes for converting cereal grains into easy-to-prepare foods that have high flavor and texture appeal plus long shelf-life.

Development of flavorful foods, nutritive feeds, and economical industrial derivatives from cereal grain fractions obtained by newly-developed air-classification methods.

Development of processes for converting wheat derivatives into insulating materials, hard boards, and foamed structures formed at place of use.

New industrial uses through chemical modifications of the different major components of cereals, such as dialdehyde starches for improved wet-strength paper and tanning agents for leather, and high-amylose starch derivatives for films and paper coatings.

Microbial transformation of cereal grain constituents (principally starch and protein fractions) for use in: toxicants, repellents, and attractants for control of insects; antibiotics for plant diseases; organic acids useful in a wide variety of industrial products; feed supplements such as modified carotenoids; and industrial products such as phosphomannans and other polysaccharides.

Fundamental and engineering investigations to develop more stable processed feedproducts of acceptable nutritive content from cereal grains and forages.

Cotton and Wool

Chemical, physical and mechanical processing research on cotton and wool and supporting fundamental and exploratory studies of their fiber properties and their modifications.

Chemical modification of cotton to give desired properties and uses such as: wash-wear garments with crease resistance, smooth-drying, and shape-holding properties; processes to impart water and oil repellency and flame, weather and rot resistance.

Development of cotton yarns and fabrics with stretch, bulk, and crepe properties.

Improved processing equipment for blending, weaving, and removing short fibers.

Chemical modification of wool to impart dimensional stability, permanent creasing, and other characteristics necessary for minimum-care garments; to improve resistance to acids and alkalies; to minimize carbonizing, bleaching, heat and light damage; to achieve more efficient felting for special uses.

Studies of the mechanical behavior of wool fibers, yarns, and fabrics as a basis for improved performance and new uses for wool.

Fundamental studies of chemical and physical properties of cotton and wool fibers necessary to the development of new products and new processes.

Oilseeds

Research primarily on soybean, cottonseed, and linseed oils, meals, and related products; investigations also include castor, tung, and selected oilseeds resulting from the new crops screening program. Research stresses new and broadened industrial uses, and seeks to improve feed and feed uses.

New chemical products derived from vegetable oils for new industrial uses -- polyvinyl ether polymers; linseed oil emulsion paints; acids, aldehydes and organometallic derivatives of industrial importance from soybean, linseed and cottonseed oils; urethane foams from castor oil; fire retardant coatings from tung oil.

Improved methods for extraction of oilseeds to achieve broadened industrial, food and feed uses.

Investigations to remove any toxic and allergenic constituents of castorseed and cottonseed to permit wider usage of these oilseeds in foods, feeds, and industrial products.

Fundamental studies on composition and properties of vegetable oils, as required for developing industrial products of economic utility and food products of higher quality, including oxidative modifications, color and flavor changes, fermentative transformations, selective hydrogenation, and polymerization reactions.

Poultry, Dairy and Animal Products

Research directed to develop new industrial outlets for animal fats and hides, and to develop new food products -- of high quality, convenience, and consumer appeal -- from milk, poultry, eggs, and the more economical cuts of meat.

Research on milk products to develop processes for improved flavor, for gelation control, for removal of any radioactive contaminants, for producing a stable, full-flavored, foam-dried whole milk powder, and for improved concentrated sweetened cream.

New ways to utilize animal fats in lubricants, in detergents, and in plastics and other polymeric products.

Faster and more efficient tanning processes to make leather more useful, especially in the garment field; chemical processes for improving water repellency of leather.

Ways to retain and improve flavor, increase stability, and impart tenderness to meat and poultry products.

Development of egg-yolk-containing and egg-white-containing products with acceptable dispersability, functionality, and flavor stability; methods for better control of microorganism, for example, Salmonelle.

New and Special Crops

Investigations directed to develop compositional data on crops from world-wide sources in an effort to find alternate crops to fill needs not now met by domestic sources; and to develop new and more economic uses for domestic special crops.

Screening of large numbers of plant materials, from both domestic and foreign sources, (a) for alternate crops, with special emphasis on sources of new types of oils for industrial uses that are not competitive with domestic vegetable oils and animal fats; (b) for new protein sources; (c) for fiber plants suitable for pulp production; and (d) for new sources of mucilaginous materials.

Investigations of new oilseeds seeking oils with properties uniquely suitable for industrial uses not now found in domestic commercial oilseeds, and non-competitive uses for the meals.

Improved techniques for the processing of sugarcane, sugarbeet, and maple sap, and developing new uses for honey.

Development of new industrial chemicals from naval stores.

Research on the chemical composition of tobacco and tobacco smoke to assist industry achieve desired quality in tobacco.

Fruits, Nuts, and Vegetables

Research to develop fruit, nut and vegetable products that are attractive, economical, nutritive and meet the increasing demand for convenience-in-use, and to develop processes and equipment for manufacture of these products.

New processes for concentrating, dehydrating (particularly foam-mat drying), freezing, dehydrofreezing, and dehydrocanning of fruits and vegetables.

Time-temperature-tolerance studies of frozen fruit and vegetable products as a basis for improvement of processes and products.

New processes for stabilizing shelled nuts against development of rancidity, darkening and other deleterious changes.

Compositional and enzyme studies to give processed fruit, nut, and vegetable products greater color stability, better flavor, and improved textural properties.

VIII. FINANCIAL INFORMATION

The F.Y. 1961 and F.Y. 1962 domestic Utilization Research and Development funds under "Salaries and Expenses, Agricultural Research Service" including allotments from the special fund for additional labor, are as follows:

	1961 (obligations)	1962 (estimated)
Cereal and forage crops	\$ 3,703,270	\$ 4,031,000 ^{a/}
Cotton, wool and other fibers	3,836,438	3,991,000
Fruits and vegetables	2,737,073	2,882,000 ^{a/}
Oilseeds	2,187,136	2,165,000 ^{a/}
New and special plants	1,618,802	1,744,000 ^{a/}
Poultry, dairy and animal products	3,934,953	3,980,000 ^{a/}
Total	18,017,672	18,793,000 ^{b/}

^{a/} Excludes amounts made available from the Contingency Research Fund as follows:

Cereals and forages

Research contract to develop methods for producing water-dispersible dried preparations of wheat gluten \$100,000

Fruits and vegetables

Research contract on constituents of dry beans causing flatulence 45,000

Oilseeds

Research on cyclopropene acids (Halphen) in cottonseed products 21,400

Poultry, dairy and animal products

Purchase of special equipment needed in new process for removing radioactive contaminants from milk 18,300

Total \$184,700

^{b/} F.Y. 1962 includes an increase of \$600,000 provided by Congress which has been distributed as follows:

F.Y. 1962 Appropriation Increase

Cereal and forage crops

Research to increase industrial and food uses of wheat and corn \$ 300,000

Cotton, wool and other fibers

Basic research on cotton 100,000

Fruits and vegetables

Basic research on flavor constituents and development of new citrus products 75,000

Oilseeds

Research on linseed and soybean oils 25,000

New and special crops

Basic studies on tobacco 100,000

Total \$600,000

In addition to the domestic Utilization Research and Development program, approximately \$1.67 million was obligated in F. Y. 1961 for utilization research projects, largely extending over a five-year period, in foreign laboratories financed by funds generated under the P. L. 480 program.

IX. IMPORTANT RESEARCH ACCOMPLISHMENTS - F.Y. 1961

New Convenience Food from Wheat

AD
A new convenience food, ready-prepared canned whole grain wheat, has been developed by Department scientists. This product can be used to contribute desirable body and texture to a wide variety of dishes such as soups, stuffing for poultry, puddings, salads, pilafs, and other foods. The new food is being test-marketed by USDA's Economic Research Service in cooperation with the Kansas Wheat Commission. Two manufacturers are in regional distribution in the Midwest and Pacific Northwest on the canned product and national distribution of a similar dried product is underway. Only a few minutes heating in a little water is needed before serving the canned product. The convenience food is cooked whole grains of wheat with only the rough outer layers of bran removed. It has a delicate whole-wheat flavor and essentially the same nutritive value as whole kernels of wheat.

Commercially-Feasible New Use for Dialdehyde Starch

A process has been developed for the tanning of sole leather in which dialdehyde starch, a new chemical derivative of cereal grain, is used as a pretanning agent followed by retanning with vegetable tan. The process, evaluated in a commercial tannery, produces commercially acceptable leather. Cost studies show that with dialdehyde starch at 30 cents per pound, a figure which should be attainable when full commercial production is achieved, the cost of the new process is competitive with conventional tanning. The big advantage is about a 50-percent saving in processing time, a definite economic gain. The new process can be applied in existing tanneries with minimum investment in additional facilities. Another advantage of the new tanning process is that the waste disposal problem -- a serious one -- is greatly alleviated.

New Cereal Products Serve as an Integral Part of Paper

New wheat flour and cereal starch products have been discovered that can be economically incorporated as an integral part of paper and other pulp products. Wheat flour and starches have been converted into water-soluble chemical derivatives that can be added to slurries of paper pulp which after a simple chemical treatment are precipitated on the pulp fibers to become part of the paper sheet. Chemicals used to make the cereal product cost only 3 to 5 cents a pound. Papers have been made in laboratory experiments containing as high as 45 percent of cereal product. The papers had higher dry and wet tensile strengths than all-wood-pulp papers. No operating conditions that would conflict with commercial paper processes were necessary. If initial findings are borne out in larger scale tests, it is expected that the cereal product might replace 10 percent of the long fiber pulp now used in newsprint; 3 percent of the coating adhesives used in coated paper; 20 percent of the pulp used in making coarse paper; and 10 percent of the pulp used in making building and insulation board. These conservative estimates would require the use of 100-180 million bushels of grain for applications not using cereal products today.

New Cereal Starch Plastics Successfully Prepared

A wide variety of new plastic-like products (graft polymers) has been prepared from cereal starch by attaching to the starch molecules polymeric chains derived from commercially available petrochemicals. Some of the products have sharp melting points, while others soften with heat and appear suitable for molding. Some are soluble in water, others in organic solvents. Certain of the soluble graft copolymers appear to be film formers. This basic research points the way to preparation of many new products from starch that can be "tailor-made" to meet specialized industrial requirements.

Dry Milling and Fractionation of Cereals and Cereal Flours

Engineering studies on the fine grinding and air classification of flours from a wide variety of hard and soft wheats -- and from sorghum, corn, rice, and soybeans -- have shown that many new and potentially useful products can be obtained. By fractionation of cereal flours, materials differing over a wide range in chemical and physical properties become available. Some of these may be expected to find use in outlets that represent new markets for cereals and their flours. Soft wheats gave low-protein fractions suitable for use in products such as paper and gypsum board, and high-protein fractions for higher valued food uses. Hard wheat yielded fractions potentially useful in industry or in food products such as cake flours or high-protein concentrates for food fortification. Small changes were noted in the properties of fractions from rice and soybean flours. Sorghum and corn flours yielded fractions that varied considerably in properties, and the lower protein flours from each have increased industrial potential.

New Species and Strains of Yeast Collected Abroad

About two hundred specimens of yeasts have been collected in Spain under a PL 480 research grant and submitted for detailed study by experts associated with the ARS Culture Collection. This activity has resulted in a number of valuable additions to the Collection. New species of yeast have been found. Some strains show carbon assimilation patterns unlike those of other yeasts. Other specimens have characteristics that should prove useful in research to develop stable inbred strains of yeast incapable of sexual reproduction that may have value for fermentative production of new chemicals. The new species and strains of yeast augment significantly resources of the Collection for exploratory studies to provide basic information on industrial use of microorganisms to obtain new products and processes by fermentation of agricultural commodities.

Visco-Elastic Properties of Wheat Gluten Explained by Basic Discovery

Wheat gluten is unique among proteins in its visco-elastic properties which are responsible for the ability of bread dough to rise by entrapping gases. These properties were shown to reside in the glutenin component which makes up 50 percent of the gluten, and which is composed of large molecules

ranging up to several million in molecular weight. Cleavage of the sulfur linkages in this component gave uniform protein molecules having a molecular weight of 21,000. This derived protein has no visco-elasticity. Thus, it is evident that glutenin is composed of polymers of the small protein molecules held together by sulfur linkages, and that this polymeric character is necessary for the unique visco-elastic properties. This basic information points the way to applied studies directed toward controlling gluten properties for both food and industrial applications.

New Soluble Gum From Corn Sugar

The ARS process developed for producing a water-soluble gum by bacterial fermentation of corn sugar is being adapted to commercial use by three manufacturers. The gum, called polysaccharide B-1459, dissolves in water to give clear, viscous solutions. These solutions have viscosities uniquely stable to heat, acids, alkalies, inorganic salts, and aging. The manufacturers foresee applications for the gum in adhesives, agricultural sprays, emulsions, oil-well drilling and flooding agents, paper and textile sizes and coatings, latex paints, leather pasting and finishing compositions, and preparations for use in the ceramics industry. The current market in the United States for water-soluble gums, which are almost entirely imported, amounts to 40 million pounds annually.

Nutrients in Dehydrated Forages Protected by Chemical Stabilizer

The major producers of dehydrated forages have announced that their total production will henceforth be treated with ethoxyquin -- a stabilizing agent whose use for this purpose was discovered by Department scientists. It is estimated that 80-90% of the dehydrated forage produced in the United States will be protected with this antioxidant, preventing severe losses of valuable provitamin A, vitamin E, and poultry and egg pigmenting factors (xanthophylls). Cooperative studies conducted at State Experiment Stations have shown that incorporation of ethoxyquin in mixed feeds also prevents certain diseases in poultry and lambs, as well as rancidification of fats in feeds. Development and commercial adoption of the ethoxyquin treatment is the result of a joint research effort involving scientists from the Agricultural Research Service, State Experiment Stations, and the industry. Extensive toxicity testing over a five-year period led to Food and Drug Administration approval for the use of the compound in dehydrated forages and mixed feeds for all types of animals. A new commercially available water emulsion of ethoxyquin has reduced cost of treatment by one-half to less than 50 cents per ton of dehydrated forage or mixed feeds.

Growth Promoter in Forages

The compound, coumestrol, previously discovered by Department scientists, has been shown to be a powerful animal growth promoter. This substance has been found in certain lots of fresh and dehydrated alfalfa and other forage legumes. In recent cooperative studies, processed forages rich in this compound were fed to fattening steers at the Nebraska Agricultural Experiment Station. The rate at which the test animals gained weight was impressive. At the Oregon Experiment Station, sheep (wethers) whose diets

included a coumestrol-rich dehydrated alfalfa showed marked increases in rate of gain over control animals receiving low-coumestrol dehydrated alfalfa. Development of methods for producing standardized, high-coumestrol forages for use in animal feeds, will provide farmers with a new, high-value market for forage crops.

New Processes Enhance Wool Usefulness

RAD

The new interfacial polymerization (IFP) treatment that gives wool fabrics markedly improved performance characteristics -- including greater shrink -, muss -, and pill-resistance and increased wearability -- is being rapidly adapted to commercially feasible processes. The process for applying the new finish, discovered by basic research, has been developed in standard commercial equipment, and the processing variables, including speeds, temperatures, and specific requirements for different fabrics, have been determined in the new wool processing plant at the Western Division. Announcement of this new IFP process, although less than a year ago, has resulted in the immediate initiation of intensive mill development studies by several of the country's largest wool mills, assisted by Department scientists and technologists. These cooperative studies are aimed at adapting the process to a continuous, high-speed treatment, under the particular conditions existing in the various plants. Many industry processors have expressed the opinion that the IFP treatment is superior to all existing commercial shrink-resist treatments.

In other utilization investigations, derivatives of corn sugar and related carbohydrates have been used successfully as intermediates in synthesis of high-molecular-weight polyamide resins that have aroused industrial interest in possibilities of their use for shrink-proofing woolen fabrics. The resins also have promise for other industrial uses such as molded articles, and coatings to meet special requirements. This research was carried out in Scotland under a P. L. 480 grant.

Industrial Uses for Wool

RAD

A rapid chemical process has been developed which greatly simplifies wool feltmaking, eliminating the need for the slow, expensive mechanical beating traditionally used to produce dense wool felts. The process is based on the discovery that the chemical, dimethyl sulfoxide, causes wool fibers to contract in length. Thus, soft wool felt treated with hot dimethyl sulfoxide becomes dense and hard within a few minutes. Hardness can be controlled by varying either the time or the temperature of the treatment. Mechanical tests show that felts made by this new process are two to three times stronger than the original, untreated felts. The hardening and toughening of the felt are permanent, because the contraction in fiber length is the result of rearrangement of the wool molecules. The new method has an advantage over present batch practice since it is adaptable to continuous processing. Commercial evaluation of the process is underway. In addition, industrial users of felts are studying the increased utility of chemically-produced felts, over wool felts produced by traditional procedures.

New Processes for Producing Stretchable and Bulky Cotton Textiles

Textiles that have stretchable characteristics are receiving widespread acceptance in both wearing apparel and industrial applications. For wearing apparel, increased bulk may also be of importance. Department scientists have been investigating three methods of producing stretchable cotton textiles and each method has excellent commercial possibilities. In one method the cotton is crosslinked while under a twisting stress, and then crimp and bulk are imparted by a stress reversing twist. Several companies are interested in this method treatment and one company considers their product ready for commercialization.

The second method being investigated is the application of standard false twisting techniques to thermoplastic cottons. These crimped, chemically modified cottons are reported by one company to be ideally suited for tropical wearing apparel.

The third method is that of completely relaxed shrinkage in mercerizing caustic solutions. Industry has demonstrated enthusiastic response to the slack mercerized products for both industrial and wearing apparel uses. Several companies have announced the availability of these products and one company is in the advanced stages of producing cotton fabrics with stretchable properties in both the warp and filling directions. Further research is in progress to perfect these processes and products so that products having the desired use-quality characteristics can be produced.

New Aerodynamic Cleaner Improves Quality of Cotton Products

A new lint cotton cleaning device, called the SRRL Aerodynamic Cleaner, has been developed by the Department to help the textile industry efficiently process cotton that has been harvested mechanically or by hand snapping. The cleaner is designed specifically to remove from cotton the motes and fine leaf (pepper) trash that are currently plaguing the cotton industry, and is used in combination with either of two lint cotton opening machines known as the SRRL Opener and the SRRL Opener-Cleaner. The combined Opener-Cleaner, Aerodynamic Cleaner units will remove up to about 45 percent of the trash from lint cotton. Although the new cleaner was just recently released, nine commercial firms are already licensed to use the development and two are known to be manufacturing the cleaner. Reports from the textile industry indicate that the device is doing an excellent job of removing pepper trash (a material which conventional cleaning equipment has not been able to adequately remove). This will aid industry in producing higher quality cotton products.

New Finishes for Producing Wrinkle-Resistant and Wash-Wear Cottons

RAD

A new class of agents for imparting wrinkle-resistance and wash-wear properties to cotton fabrics has been developed and tested on a laboratory scale by USDA scientists. The finishing agents employed are dimethylol mono-carbamates. The treated fabrics have good wash-wear properties and the finish is durable to multiple launderings. A highly desirable feature is the resistance to the chlorine bleach almost universally used in laundering. Potential low cost, ease of preparation, standard methods of application, and the good appearance and durability of the finished cotton fabric combine to give the method great commercial promise. Specific agents of this general class are being investigated to determine their suitability for commercial use.

An investigation of the reaction of formaldehyde with cotton has provided fundamental information about the mechanism for changing the physical properties of cotton which has resulted in the development of several new processes for the production of wash-wear cottons. In one of these processes wet wrinkle resistance is imparted to cotton fabric, thus providing line-dry fabrics. Other processes produce fabrics having the desirable property of dry wrinkle resistance in addition to wet wrinkle resistance. The most recently developed vapor process achieves these results with very low amounts of formaldehyde combined with the fabric and may be applied to completed garments, such as shirts. The finishes are durable to laundering and to chlorine bleach, characteristics necessary for good wash-wear performance. Two of the processes have been applied on commercial type equipment and several textile mills are actively engaged in evaluating them. Because of the low cost of the chemicals employed, the formaldehyde processes should be very economical. This work has stimulated a reexamination of this type treatment by industry, and several companies are reported to be producing wash-and-wear cottons using formaldehyde.

Flame-Resistant Cotton Products

RAD

Good progress has been made in research to improve the light and weathering resistance of the "APO-THPC" flame-retardant finish for cotton fabrics, a superior flame retardant previously developed in cooperation with the Quartermaster Corps. By changing the ratio of the chemicals employed in the APO-THPC treating formulation, the outdoor service life of medium-to-heavy fabrics has been increased by 40-50% (to approximately 18 months). This service life approaches the useful life of textiles subjected to intermittent exposure to weathering. Research is continuing to effect further improvements in this type flame-resistant finish for use on tents, tarpaulins, boat covers, and certain types of industrial fabrics.

Fundamental Information on Microbiological Breakdown of Cotton

Cotton fabrics in many applications are exposed to bacteriological and fungicidal attack. Fundamental research at the Shirley Institute, Didsbury, Manchester, England, involving P.L. 480 funds, has resulted in the development of important information on the biochemical pathways involved in the microbiological breakdown (hydrolysis) of cotton cellulose. Studies of the enzyme systems involved have shown that these systems consist of at least two types. One of these, less of which is present in isolated enzyme preparations, appears to penetrate the cellulose more readily. This would explain the significantly greater degradation of cotton by living organisms compared to the limited degradation by the isolated preparations. Research in progress should enable the development of laboratory test methods that will simulate more closely actual service conditions of cotton products, thereby aiding in obtaining information that will facilitate the development of more effective preservative treatments for cotton.

Practical Method for Imparting Weather and Rot Resistance to Cotton Fabrics

A practical, low cost treatment, developed for making cotton fabrics exposed to mildew, rot, and weathering last much longer, offers promise of maintaining a market of approximately 230,000 bales of cotton a year in canvas goods products such as awnings, tarpaulin, tentage, field coverings, beach umbrellas, ditch liners, and irrigation pipes. The treatment uses a chemical called "acid colloid of methylolmelamine", and can be applied with equipment already available in a great many textile finishing plants. One finisher has produced the colloid-treated fabric and supplied it to approximately six consumers who are using it as ditch liners, dam stops and in other applications. Other samples are under experimental exposure as seed bed covers in Florida. Further interest in the development is anticipated.

Machine for Rapidly Determining Foreign Matter Content of Cotton

A completely self-contained and compact machine, called the Trash Analyzer, has been developed for rapidly determining the foreign matter content of lint cotton. The machine is capable of 95% cleaning efficiency at 60 pounds per hour production. Trash content of a bale of cotton can be determined in less than 5 minutes with this machine, as compared with one hour with conventional machines. The Trash Analyzer is being evaluated over a wide range of grades and qualities of cotton. It is a tool long needed by the industry and its use will aid manufacturers in producing higher quality cotton products.

Basic Information on Fabric Failure Developed by Microscopical Study

Research employing light and electron microscopy has contributed new information toward a better understanding of fabric failure. The results of flexural strain, compression, and frictional wear can be seen, especially at the submicroscopic level. In fabric-to-fabric flat abrasion tests on gray cotton, the surfaces of cotton fibers appeared considerably damaged when examined with the electron microscope by the replica technique. This study of fabrics, yarns and fibers under varying conditions of abrasion should contribute to a better understanding of the breakdown of fabrics in everyday use and toward potential improvement of abrasion-resistant treatments. Increased utilization of cotton should result from the development of fabrics having improved abrasion resistance.

Chemistry of Meat Flavors

The factors responsible for flavor and aroma in meats have been resolved into several principles. First, flavor is derived from some of the water extractable substances in meat. Second, the substances extracted are not flavors but precursors which develop flavor on heating. Third, lean beef, pork, and lamb have a similar flavor; but contributions from the fatty tissue confer flavor differences characteristic of the species. For example, lamb fat contains non-triglyceride material that on heating releases minute amounts of carbonyls responsible for most of the characteristic lamb aroma. Flavor substances, isolated and studied to date, include amines, sulfide compounds, carbonyls, and fatty acids. The substances from which these were derived have been identified as low molecular weight carbohydrates, polypeptides, and amino acids which produce flavor by their interaction. These new facts concerning meat flavor provide a basis for the development of improved processing, handling, and preservation aimed at the production of better flavor meat and meat products.

Removal of Strontium 90 from Milk

The U. S. Department of Agriculture, the U. S. Atomic Energy Commission, and the U. S. Public Health Service have undertaken a joint research effort to develop a feasible commercial-scale process, to be used in case of national emergencies, for the removal of radioactive contamination from milk. A continuous pilot plant process, using commercially obtainable equipment, has been developed which removes over 90% of strontium 90 in a single pass through a resin bed with little or no effect upon the flavor and stability of the milk. It is estimated from these pilot plant studies that such removal of strontium 90 would cost in the order of 5¢, or perhaps higher, per quart of treated milk. The research is continuing in an effort (a) to refine the resin regeneration phase, (b) to explore other removal procedures that might be more efficient and (c) to study the problems of adapting a pilot plant process to commercial use.

Dried Cheese Whey - A New Product

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Cottage cheese whey, which had hitherto not been dried, now can be successfully dried by a new ARS method of foam-spray drying. At present, three billion pounds of cottage cheese whey produced annually and containing half the solids of milk are wasted into sewers and streams. With the development of stream pollution control and urban charges for sewer use, cottage cheese plants are faced with heavy disposal expense and even forced closing. Following publication of the new method, inquiries were received from virtually every large dairy company and dairy equipment manufacturer in the United States. It is anticipated that the method will find wide commercial adoption. Its use may avoid the closing of factories and it will provide a new dairy ingredient for food manufacturers.

Autoxidation in Fatty Foods

Basic studies to determine the role of major food components, including fats, in autoxidation and "off-flavor" development, have shown that histidine, one of the common amino acids of proteins, has a profound effect on autoxidation of fats. In aqueous emulsions of fats it is a powerful pro-oxidant, and if traces of iron salts are also present the pro-oxidant effect is greater than when either histidine or iron salts only are present. Phosphates nullify the pro-oxidant effect of histidine. The findings are of importance to a better understanding of factors that promote or retard autoxidation in fatty foods, and should point the way to a practical solution of the off-flavor problems in many food products.

Surfactants from Tallow

Utilization research has shown that alpha sulfoacids prepared from tallow are effective lime soap dispersing agents, and may be expected to be useful in the form of soap-detergent combinations. It has also been discovered recently that certain esters of the alpha sulfoacids are especially effective as wetting agents. Since they compare in effectiveness with the best known commercial wetting agents and are also potentially very cheap to manufacture, commercial interest in them seems assured. In the meantime, manufacture of alpha sulfoacids has been undertaken by several commercial concerns.

New Apple Juice Product

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A market test recently conducted by AMS in cooperation with ARS and industry has shown the USDA-developed 7-fold superconcentrated apple juice to have an excellent public acceptance. In consequence, a large Middle West processor will manufacture it this season for household use. This product rapidly reconstitutes to give a juice having the aroma and flavor of fresh juice. It has already been manufactured on a commercial scale for use by the jelly industry. However, this market test will open the way to expanding its use as a beverage.

Basic Studies Aid Sausage Manufacture

Excellent progress has been made in studies, conducted at the Research Institute of Meat Technology, Hameenlinna, Finland, under a P. L. 480 grant, on the effect of various microorganisms on the development of flavor (aroma), color and other desirable chemical changes occurring during sausage manufacture. Over 700 strains of organisms obtained from curing brines used for curing hams and sausage have been screened for their ability to affect certain qualities (color, flavor, etc.) in the finished product. The conclusions reached from the results obtained so far are that no single strain of bacteria can produce all the changes desired in the ripening of dry sausage, but a mixed culture composed of several strains will be required to effect these changes. This will entail a detailed study of a very large number of organisms, but the fundamental results obtained undoubtedly will be of great value in devising methods of manufacturing improved sausage and other cured meat products.

Research Finds a Major Cause of Egg Spoilage

Basic studies of the nature of bacterial growth in egg white have revealed that trace amounts of iron counteract the protective action of the protein, conalbumin, in egg white and thereby permits spoilage. Applied studies based on this finding have shown that iron in the water used to wash eggs can be high enough to markedly influence spoilage. With wash water containing 5 to 10 parts per million of iron, a level commonly found in well water, spoilage is three-to eight-fold that obtained with water containing less than 0.5 parts per million of iron. This discovery is helping egg producers and processors reduce the serious shell egg spoilage that accounts for a loss of approximately \$20 million annually. Major egg producers are starting to treat wash waters to lower iron content to 0.5 parts per million before eggs are washed prior to shipment, in order to eliminate excessive spoilage.

Levopimaric Acid from Pine Gum

Levopimaric acid is an important, reactive resin acid present in pine gum. It would be a valuable intermediate in the chemical industry if practical processes were available for isolating it from the gum in a pure form. Department scientists have succeeded in developing a laboratory procedure which produces levopimaric acid salt of 90% or higher purity in good yield, from pine gum. Indications are that it will be possible to isolate the pure acid without altering the composition of the turpentine or decreasing the value of the residual rosin. Additional research is underway to develop information needed for possible commercial scale use of the procedure.

Basic Compositional Studies of Tobacco

Significant progress has been made, in cooperation with the Cigar Manufacturers Association of America, in the isolation and identification of the numerous chemical compounds which account for the color, aroma, and leaf pliability of tobacco. Aliphatic and cyclic paraffins, terpenes, tocopherols, sterols, and at least fifteen higher fatty acids and their esters were characterized. In addition to the fatty acids, which contribute to the flavor and aroma of tobacco smoke, other complex highly aromatic mixtures were isolated.

New Crop Seed Oils Containing Epoxy-Fatty Acids for Plastic Composition

Ironweed seed, Vernonia anthelmintica, a potential new crop, contains 20 percent of oil the principal component of which is epoxy oleic acid, a compound which has application in plastic compositions. Research has shown that the oil from fresh seed, extracted promptly after grinding, contains 65-70 percent of epoxy oleic (vernolic) acid combined almost entirely as glycerides. The seed contains an active lipase which rapidly hydrolyzes the glycerides and produces free acids unless the extraction is done promptly after grinding the seed or unless the enzyme is deactivated. A process for deactivating the enzyme without destruction of epoxy acid has been developed. A method has also been developed for isolating the triglyceride of epoxy oleic acid from the crude oil in 95% purity and in good yields. This finding is an important step in providing a relatively pure material for future work in the evaluation of the trivernolin and its chemical derivatives for industrial use in the field of plastics, polymers and surface coatings.

Valuable Chemicals Found in Wild Plants

Substantial percentages of novel components, many having significant industrial potential, are present in a number of the 3400 samples of uncultivated plants analyzed. Recently discovered products include vegetable oils unlike those commercially available and new carbohydrate seed mucilages. The new oils have been converted in the laboratory to plasticizers, foamed plastics, dibasic acids for polymers, and waxlike substances. Co-product meals of some oilseeds have been upgraded for feed use by newly developed processes. The seed mucilages are effective as additives for increasing paper sheet strength. These uncultivated plant samples come from both domestic and foreign sources through cooperating agencies in the Department. Projects under Public Law 480 provide many foreign species. Species desirable both agronomically and industrially can lead to development of new crops offering greater latitude in farmers' choice of commodities for profitable land use.

Efficient Plasticizers from Cottonseed Fatty Acids

Attractive plasticizers for vinyl chloride plastics have been produced from the fatty acids of cottonseed oil. One of these plasticizers, the morpholide of selectively hydrogenated cottonseed fatty acids, is superior to the commonly used "DOP" plasticizer in efficiency, volatility and low-temperature performance, and comparable in thermal stability. Another type, the morpholide of partially epoxidized cottonseed fatty acids, has an even higher efficiency and lower volatility and imparts a markedly greater thermal stability to the vinyl chloride resin used in the plastics, though at some sacrifice in low-temperature performance. In addition to being a good plasticizer, it is also an efficient vinyl chloride stabilizer. Several industrial companies are evaluating the new products in various applications.

Cottonseed Oil Color Improved

From 25% to 50% of domestically produced cottonseed oils contain reddish colorations that are not satisfactorily removed by present commercial refining, bleaching, and deodorizing methods. These oils are discriminated against and have reduced market value. Research by Department scientists has shown that activated alumina is a satisfactory bleaching agent for these off-color cottonseed oils. The activated alumina used in the new bleaching process has been found to be about sixteen times more effective than Fuller's earth conventionally employed in bleaching cottonseed oil. The spent alumina can be reactivated and reused indefinitely without loss of its effectiveness as a bleaching agent and with little loss of alumina. The new process has no adverse effect on important oil properties. Pilot-plant work on bleaching cottonseed oils with alumina is in progress to show whether the cost of alumina bleaching will be competitive with present refinery procedures for processing off-color oils, and to develop information necessary for possible commercial scale use of the process.

Solvent-Blown Urethane Foams from Castor Oil

RAID

The preparation of light weight plastics, known as urethane foams, based on castor oil, has resulted from earlier Department research. These foams were prepared by the foaming action of carbon dioxide gas produced as a result of the chemical reaction of water with one of the components of the polymerization mixture. A method for preparing improved castor-based foams has been developed in which the foaming is produced by vaporization of a low boiling solvent due to the heat of reaction generated during polymerization. Such foams may be used as upholstery materials, crash pads, for thermal and acoustical insulation, light weight structural materials and numerous specialty products. In general, such light weight solvent-blown plastics are stronger and have better thermal insulation properties than the analogous water (carbon dioxide) blown foams. Commercial evaluation of such foams based on castor oil is underway.

Basic Allergens Research

Utilization of castorseed meal, a rich source of protein, is limited because of the presence of very potent allergens. Many humans become sensitized by extremely small amounts of the dust from the meal and thereafter react violently to exposure. Department scientists have demonstrated that castor meal contains at least six proteins which cause allergic reactions in monkeys sensitized with serum from humans allergic to castor. These findings have led to the development of a new diagnostic test for allergenicity, in which inexpensive Philippine Old-World monkeys, instead of allergic humans, can be skin tested repeatedly. In other studies, a process has been devised that appears promising as a commercial method for inactivating the principal allergenic constituents in castorseed meals.

Solution of the castorseed allergen problems, made probable by these discoveries, gives promise for growing castor as an industrial crop on large acreages in the U. S.

New Process for Soybeans in Commercial Use

During the past year, two soybean processors have installed commercial-size flash desolventizer units based on the original designs and pilot-plant development of the Department. These desolventizers were developed to remove solvent from extracted soybean meal without damaging the protein by excessive heating. Meal quality, as determined by water solubility of the protein, can be controlled over a wide range by simple adjustment of operating conditions. Use of this process permits the economic production of undenatured extracted soyflours and will promote the further development of high-quality soybean protein food products. The equipment required for the flash desolventizer is of simple construction and flexible design so that it can be added to existing plant facilities at low cost without major building revisions. It is unique in that it contains no moving parts in the desolventizing zone.

New Chemicals from Soybean Oil Show Industrial Promise

Ozonization of soybean oil or its fatty acids has yielded a variety of new chemical derivatives that have attracted widespread industrial interest. One type of derivative, called "MAZ" is an ester of a reactive aldehyde and shows much promise as a cross-linking agent for synthetic polymers and as an intermediate for novel types of acetal resins. Another type of derivative, called "aldehyde oil," retains the glyceride structure of the original oil and can be prepared in several forms having different degrees of reactivity towards other chemicals. Uses in plastics, resins, plasticizers, paper and textile chemicals are being explored. Process economics appear to be very favorable for these new chemicals which have raw material costs of 12 to 23 cents per pound. Potential market areas for MAZ and aldehyde oils now consume 3 billion pounds of organic chemical products annually. These new chemicals are now being commercially evaluated.

"Hidden Oxidation" a Major Factor in Quality of Soybean Oil

The most important problem of the soybean oil industry is development of objectionable flavor during storage of the oil or upon exposure to heat when used as a cooking oil. Most of the volatile flavor components of these oxidative decomposition products are removed during the deodorizing stage of the refining. However, utilization research found that about 90 percent of the total decomposition products remain in the refined oil. Studies have shown that these residual products undergo further changes with time to reduce the flavor and oxidative stability of oil which may appear to be of high quality immediately after refining. These effects from unremoved oxidative products have been called "hidden oxidation." A method for detecting hidden oxidation has been developed by the Department, and industry is now testing it. This test reveals the history of the oil and provides information on its future stability for use as salad oil.

Fast-Drying Linseed Oil Emulsion Paint Developed

Stable linseed oil-water emulsion paints have been prepared that dry-to-touch, develop excellent water resistance, and can be recoated within 15 to 30 minutes after application. The paints can be thinned with water, and water can be used for brush clean-up. Samples evaluated by six cooperating industrial companies compared favorably with commercially available synthetic resin emulsion paints in brushing, wet-edge, hiding, drying, and other essential properties. They were superior to many of the commercial synthetic resin paints in leveling, blister resistance, and adherence to chalky weather surfaces. Outside weathering and long-term storage tests, and additional formulation studies to obtain the best combination of properties are being undertaken preparatory to commercial production of these paints.

New Emulsifiers Made from Linseed Oil

Nonionic emulsifiers of several types have been prepared from linseed oil by chemical derivatization of linseed fatty acids or linseed fatty alcohols. These new emulsifiers have properties uniquely different from conventional products now in use. When used to formulate linseed oil emulsion paints, the new emulsifiers appear to exert a specific stabilizing effect when the paints contain zinc oxide as one of the pigments. When such paints are formulated with conventional emulsifiers, they almost always increase gradually in viscosity until they become too thick to be used. With the new linseed oil derived emulsifiers, formulations are easily achieved having viscosities that have remained stable for more than 2 years. Emulsion paints made with these new products are being evaluated by six industrial companies.

Edible Gels and Foams Made from Soybean Protein

AD
Edible gels and foams have been made from refined soybean protein that have been good potential for both food and industrial uses. The gels, which are the first heat-reversible gels made from a vegetable protein, become liquid when heated and thicken when cooled. Foams made from solutions of the refined protein are unusually stable -- several times more so than other foam products tested for comparison. They offer wide potential in many types of food products -- giving them added desired texture and flavor properties.

Dehydrofreezing of Fruits and Vegetables Gains Broad Acceptance

AD
Dehydrofreezing is a new method of food preservation developed by Department scientists, whereby foods are partially dehydrated and then frozen. The process is now in commercial use. Several million pounds of dehydrofrozen apples are being produced each year for use in commercial bakeries. Dehydrofrozen peas, carrots, and potatoes are being manufactured in rapidly increasing tonnages and are becoming important export items. Three million pounds of dehydrofrozen pimientos were produced last year for use in cheese products. A large food concern has just completed a successful market test of dehydrofrozen baby foods, including fruits, vegetables, soups, meat dinners and puddings.

In the new process, dehydration is limited to removal of about half of the water present to avoid the irreversible quality damage that occurs during some stages of complete drying. The reduction in product weight and volume achieved by partial dehydration results in large savings in costs of freezing, packaging, handling, and shipping. Fresh flavor, texture, and color are retained by keeping the product frozen. Less drip on thawing and easier moisture control during remanufacture are among the advantages of dehydrofrozen over conventional frozen foods. The fresh-product quality, the convenience, and the economy of reconstituted dehydrofrozen foods assures expanding acceptance of dehydrofreezing as a method of food preservation.

A Better Dry Bean Product

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Objective scientific research has not only established the cause and effect relationship between dry bean ingestion and flatulence, but has also yielded a reproducible method for demonstrating this relationship. A variety of bean products, including canned pork-and-beans, oven-baked beans, canned dry Limas and canned green Limas, have been examined and have all been found to cause the same response. It has also been demonstrated that contrary to popular belief, the causative agent is not the high fiber content of beans, nor the resistance of the cell walls to digestion in the upper intestine. The substances in beans which cause flatulence have not yet been identified, but the development of a reliable, quantitative method for studying the phenomenon has removed the major barrier to this research, and should speed the identification of the substances responsible. This will lead to modified processing procedures to eliminate undesirable effects.

The present farm value of dry beans is about \$110 million annually. Development of dry bean products devoid of flatulence-producing properties could double or treble the demand for this inexpensive but highly nutritious food.

New Antimycotic Agents Discovered

Chemical preservatives, called sorbates, are now being used successfully on a commercial scale as antimycotic agents on retail packs of high-moisture dried prunes and figs. The utility of these compounds for this purpose was discovered by utilization scientists. Sorbates are also being used on bulk packs of these fruits for domestic and foreign shipment. The residual antimycotic effect is the most important attribute of this treatment, and represents an important advantage over the agents that were used for many years. The farm value of prunes and figs has been in excess of \$50 million for the past several years and the value of the processed products is substantially greater than this. Six of the largest packers of these dried fruits now use sorbates on the major part of their packs. This is benefiting the growers by extending the domestic and foreign markets for these products.

Breakthrough in Bacterial Spore Research

The great resistance of bacterial spores to heat makes it necessary to apply severe processing schedules in the canning of non-acid foods. This results in quality losses, and makes impossible the canning of certain commodities. Basic research on the nature of the heat resistance of spores has been impeded for decades by the difficulty in obtaining substantial quantities of "clean" spores, free of vegetative cell debris and medium particulates. This problem has now been solved by development of a two-phase solvent extraction system that makes possible the recovery of clean spores of Clostridium botulinum from dead cultures with a very low (1%) spore population. In other species, it has proved effective in removing very small amounts of subcellular debris. This accomplishment is a major breakthrough in microbiological research and has implications far beyond the solution of agricultural problems.

Fundamental Research on Food Stabilizers

Basic research, being conducted in the United Kingdom under a grant through Public Law 480, is providing important information on the relationship between molecular structure and antioxidant activity. Among the antioxidants studied have been complex chemical compounds called polyphenols. These compounds have yielded some particularly valuable information on structural features necessary for antioxidant action. This information will prove of value in the design of practical antioxidants which combine the ideal structural features with commercial availability. The importance of this basic research is recognized since expansion of markets for many food products is limited by rancidity that develops in these products on storage. This rancidity, caused by oxidative deterioration of fats, can be inhibited or prevented by addition of trace amounts of suitable antioxidants. These fundamental studies are invaluable guidelines for developing antioxidants that are adequately effective and acceptably safe for use in foods.

Dehydrated Mashed Potatoes Make Further Gains

A new "direct" process for the manufacture of dehydrated mashed potatoes in the form of granules yields an instantly reconstitutible product of uniform high quality. Cooked potatoes are dried and granulated in a series of operations which eliminates any recycling of partially dried product. New procedures and specially designed equipment make it possible to separate the delicate potato cells and dry them with a minimum of mechanical damage. Invented by utilization scientists, the process is undergoing intensive industry evaluation, and may well lead to greatly increased production, presently exceeding 150 million lbs. annually of dehydrated mashed potatoes (flakes and granules).

Cherry Brining

During the past several years, growers have suffered sizable losses due to the sporadic and unpredictable deteriorative softening of cherries during brining. The direct loss to the grower resulted from the withholding of crop payments until the brined cherries were examined several months after brining. Research on this problem has yielded reproducible sampling procedures, and a simple objective method for measuring texture of the brined cherries. The mechanisms of softening have been identified by basic enzyme studies. Pectinolytic degradation has been shown to play a major role in softening. In addition, breakdown of the tissue cellulose and hemicelluloses occurs, presumably by a chemical process since cellulytic enzymes are not involved. This basic information, confirmed by model system studies, provides the information needed by the industry to develop modified brining procedures which will prevent softening. Potential losses to growers of as much as \$5 million per year can thus be prevented.

Flavor Components of Onions Identified

Improved products from a large variety of fruits and vegetables may be possible as a result of basic research on the flavor components of onions. Isolation and identification of the volatile flavor components of sliced onions furnished clues which led to the identification of precursor materials from which flavor components are derived. This in turn led to the isolation of an enzyme from onion capable of producing onion-like flavors from these precursors. Studies of these enzymatic reactions showed that chemical determination of the amount of a substance called pyruvic acid present in the onion can be used as an objective measurement of pungency. High pungency is desired in onion varieties used for processing. As a result of this research, the plant breeder can judge more accurately and more quickly whether varieties are suitable for processing. These findings suggest areas of research on other fruits and vegetables aimed at determining flavor precursors, and isolating flavor enzymes and determining their stability during processing. Greatly improved processed products will thus result.

Fruit Juice Concentrates Improve Frozen Dessert Flavors

Fruit juice concentrates with their accompanying concentrated aromas (essences) are a Department development. Their use has until recently been confined to making jelly of improved flavor. In cooperation with a Land-Grant College, concentrates and essences from seven important fruits and berries were evaluated as flavoring agents in ice cream, sherbets, ices, ice milks and variegated ice cream. The optimum level of flavoring materials, the basic mix composition, as well as sugar and acid contents were determined. Most of the fruit concentrates and essences were found, by consumer test panels, to be a valuable and economically practical means of improving the flavor of fruit ice cream and related products, either when used as a fruit supplement or when used as the only source of fruit flavor. These findings including recommended formulations and cost data are being made available to commercial ice cream manufacturers and should increase the consumption of both dairy and fruit products.

New "Instantized" Dehydrated Foods

Conventionally dehydrated vegetables, for example 3/8" carrot and potato dice, require from 20 to 30 minutes boiling to be ready for eating. A new process under pilot plant development shortens this time to 5 minutes. It also enables more rapid dehydration of large pieces formerly requiring inordinately long times to dehydrate and to reconstitute. The new process gives the dried piece a porous structure, which assures rapid reconstitution with boiling water to give texture and flavor comparable to the freshly cooked piece. The process has thus far been successfully applied to potatoes, carrots, beets and corn, and should be applicable to other vegetables as well as fruits. The dehydrated soup industry has manifested considerable interest in the new process as it will permit the use of large vegetable pieces instead of the small fragments now necessary in a soup requiring about 10 minutes to prepare.

Precooked, Dehydrated Sweetpotato Flakes

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A flavor-stable precooked, dehydrated sweetpotato flake product, previously developed by Department scientists on a small pilot-plant scale in cooperation with the Quartermaster Food and Container Institute for the Armed Forces, is now being produced on a semi-commercial scale. As part of National emergency planning, an industrial preparedness study has been completed for the Quartermaster Corps (under contract), and plant designs and costs for proposed commercial operations have been distributed to industry. Industry interest is high for this new product that can be reconstituted in 60 seconds and has the color and taste of freshly cooked mashed sweetpotatoes. One commercial firm is reportedly undertaking limited commercial production of the flakes this season to ascertain the commercial potential of the product. Commercial exploitation of the product will further the economy of the sweetpotato industry by affording a profitable outlet for a substantial proportion of the crop, as much as 6-8 million bushels annually, which is substandard for the fresh market and not adequately absorbed by the demand for canned and frozen products.